MICROTRONICS
M·65

HAM INTERFACE FOR THE PET MICROCOMPUTER

INSTRUCTION MANUAL

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Revised 1/5/79

M-65 90 Day Limited Warranty

For a period of ninety (90) days after purchase, MICROTRONICS will refund in full the purchase price minus postage of any factory assembled M-65 which is found to be unsatisfactory by the purchaser. At the purchaser's discretion, MICROTRONICS will replace or repair free of charge any M-65 which is found defective. And that includes the shipping charges anywhere in the world.

For a period of ninety (90) days after purchase, MICROTRONICS will replace or repair free of charge any parts that are defective either in materials or workmanship on any M-65 purchased in kit form. You can obtain parts by writing to us at the address below or by telephoning us at (209) 634-8888. If a defective part or error in design has caused your M-65 to malfunction during the warranty period through no fault of yours, we will service it free upon proof of purchase and delivery at your expense to the address below.

You will receive free consultation on any problem you might encounter in the assembly or use of your M-65. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

Our warranty does not cover, and we will not be responsible for damage caused by the use of any solder other than that provided with the kit, defective tools, excessive heat while soldering, incorrect assembly, misuse, improper wiring or handling of connectors, fire, or by unauthorized modifications. This warranty does not cover reimbursement for customer assembly or set-up time.

This warranty covers only MICROTRONICS products and is not extended to allied equipment or components used in conjunction with our products. We are not responsible for incidental or consequential damages.

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January 5, 1979

Addendum

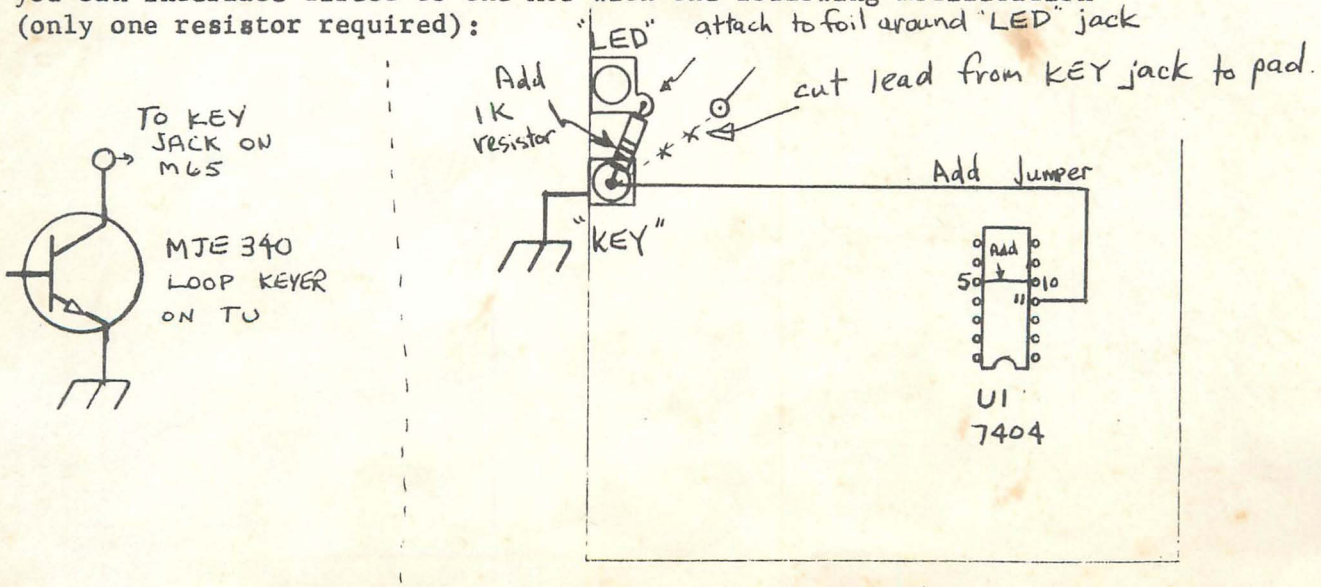
Version 1.2 of Program RTTY now provides for selectable baud rates (60, 66, 75, and 100 words per minute). In the Send Mode:enter:
CLR %
Then enter the desired speed - this controls both sending and receiving speeds.

Solid State Keying

For those of you who would like to operate very high speed CW, or if you have a transmitter which has a keying circuit which exceeds the reed relay capacity (the relay frequently hangs up on the Yaesu FT101 for example), MICROTRONICS now has available a plug-in replacement for the relay. The MSK-1 provides both positive and negative voltage keying. Price of the MSK-1 is$14.95.

Additional note for RTTYers

If you use an external terminal unit with an MJE 340 transistor loop keyer (such as the Flesher DM170, ST4, ST5, ST6, ST5000, Digiratt, etc.) you can interface direct to the M65 with the following modification (only one resistor required):



External T.U

M65 Board

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FOREWORD

Congratulations! With the purchase of the M-65 you have converted your PET™ microcomputer into a state-of-the-art Ham Computer System. Whether it was the high speed CW capability, the extensive programmed message memories, the automatic time sending feature, or one of the many other features of this microcomputer system which influenced you to buy the M-65, we feel that you will find that it adds a whole new dimension to your "shack". It really is a thrill to add to a QSO: RIG HR IS..... AND PET MICROCOMPUTER WITH M-65 HAM INTERFACE !

Please send in the attached registration form - it not only serves to validate your warranty, but also will allow us to keep you informed of new developments in software for your M-65 (and many exciting features will be ready in the near future). We welcome comments and suggestions for improvement of our product. Please drop us a line if you have any suggestions or questions. We will periodically compile these and distribute them in the form of a newsletter to all owners.

Best of luck and hope to meet you on the air!

73, Ron

Ron Lodewyck, N6EE
President

PET™ is a registered trademark of Commodore International, Palo Alto, CA.

M-65 PARTS LIST

Part ID #	Quantity	Description	Marked
-	1	Printed Circuit Board	
OI1, 2	2	Optical Isolator.	SOC 1 or MCT2 or IL-1
RL1	1	Reed Relay	
U1	1	7404	
U2	1	7486	
U3	1	567	
U4	1	555	
-	4	8 pin IC socket	
-	3	14 pin IC socket	
R14	1	10 K TrimPot.	RED or WHITE
R15	1	50 K TrimPot.	BLUE or BLACK
-	1	Light Emitting Diode (LED)	
CR1, 2	2	Diodes	
-	6	Phono Jack	
-	1	Phono Plug	
-	1	12 position edge card connector	
-	1	6 position edge card connector	
R2	1	270 ohm resistor.	Red/Violet/Brown
R3,4,6	3	330 ohm resistor.	Orange/Orange/Brown
R1	1	1 K ohm resistor.	Brown/Black/Red
R9, 12	2	2.2Kohm resistor.	Red/Red/Red
R16, 17	2	4.7Kohm resistor.	Yellow/Violet/Red
R10	1	5.6Kohm resistor.	Green/Blue/Red
R7, 13	2	10 Kohm resistor.	Brown/Black/Orange
R11	1	68 Kohm resistor.	Blue/Gray/Orange
C6	1	22 mfd Capacitor	
C7	1	.022 mfd Capacitor.	223 or .022
C4	1	.047 mfd Capacitor.	473 or .047
C3, 5	2	1.0 mfd Capacitor	
C2, 8, 9	3	0.1 mfd Capacitor	
C1	1	.01 mfd Disc Capacitor.	103 or .01
WIRE	10"	Hook up wire	
R8	1	3.3Kohm resistor.	Orange/Orange/Red
-	36"	Two conductor cable - polarized	
-	2"	Heat Shrink tubing	
-	36"	Rosin core solder	
-	1	Audio cassette - MORSE & RTTY programs	
-	1	M-65 Instruction Manual	
-	1	Warranty Card	

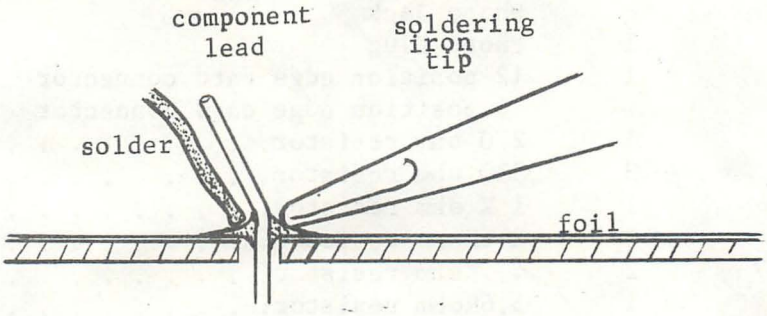
ASSEMBLY INSTRUCTIONS

If your M-65 was purchased in assembled form, skip this section and proceed directly to the section labeled Operating Instructions.

General Information

1. Tools. You will need: long nose pliers, diagonal cutters, wire strippers, combination pliers, and a small tip (1/8" chisel) low wattage (25 to 40 watts) pencil type soldering iron.

2. Soldering Technique. Do not use a soldering gun or iron with more than a 40 watt rating. Keep your soldering iron tip clean with a damp cloth or sponge. Press the soldering iron tip against the component lead and the circuit board foil. Heat both for a second or two. Apply solder to the opposite side of the component lead as shown below:



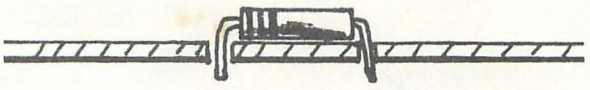
Do not feed the solder to the iron tip - let the lead and foil melt the solder. The solder should flow evenly and smoothly around the connection. Remove the iron quickly - never heat the foil or a component more than a few seconds. Excessive heat will damage most components - especially diodes, LEDs, and ICs - and cause the foil to separate from the board (causing irreparable damage).

3. Parts mounting.

a. Resistors. Some resistors will be vertically mounted and some will be horizontally mounted.

i) Vertical mount. (R1,2,3,4,6,7,11,12,13) Bend one lead down parallel to the body:

ii) Horizontal mount. (R8,9,10,16 and 17) Bend both leads perpendicular to the body:



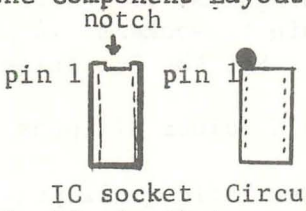
b. Capacitors. Mount disc, mylar, polyester, or tantalum types vertical by simply inserting both leads in the appropriate holes in the board. Positive polarity will be indicated on some capacitors with a + marking or a color dot. Mount the electrolytic capacitor horizontal by bending both leads perpendicular to the body. Polarity may be marked with either a + or a —. Position with the — side toward the ⊖ on the board.

C. Trim Pots (R14 & 15) Since the holes in the board are much larger than the leads, make certain that the lead is touching the foil and is well soldered.

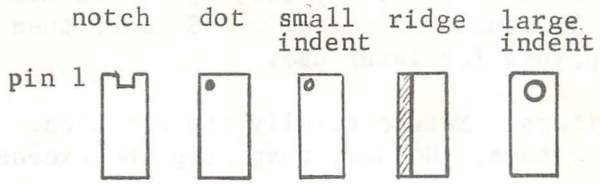
d. Diodes. The banded ends of diodes can be marked in a number of ways:

The diodes are mounted horizontally by bending the leads perpendicular to the body. Diodes are very heat sensitive - heat sink the leads with a long nose pliers while soldering and use a minimum of heat.

e. IC Sockets. Line up the notched end of the socket with the circle on the board. Refer to the Component Layout Diagram. The dot is nearest pin 1 of the IC.



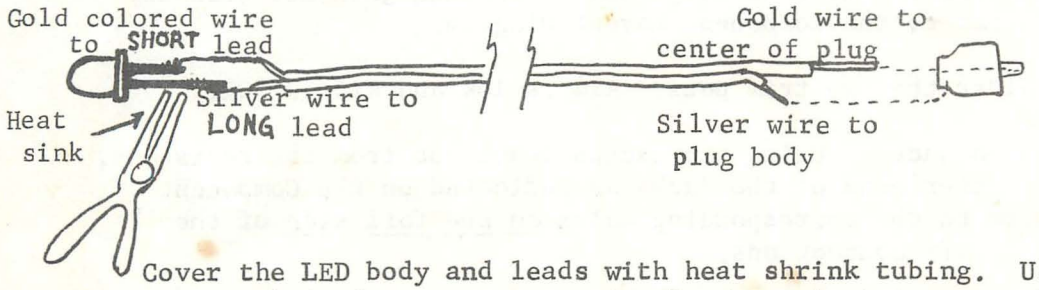
f. ICs. Do not install the ICs in their sockets until all assembly is complete. Pin 1 may be indicated in several ways:



Refer to the Component Layout Diagram for placement.

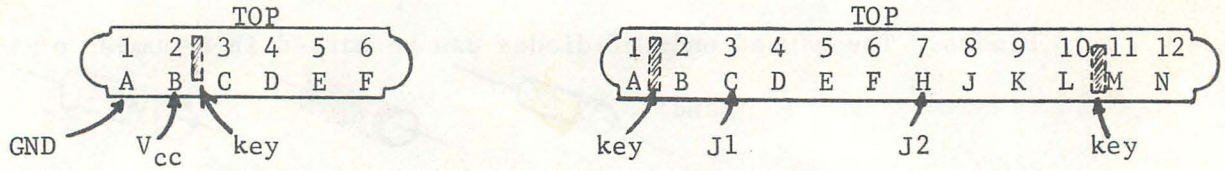
g. Phono jacks. Remove the solder lug and place in each of the six large holes with the washer and hex nut on the foil side.

h. LED. The LED is attached to a cable assembly as shown below:



Cover the LED body and leads with heat shrink tubing. Use a high wattage hair dryer or -caustiously- an electric range burner, to shrink the tubing. Use a razor blade to trim the tubing around the body of the led to make it look neater.

i. Edge Card Connectors. Note the polarizing keys inserted between the pins: On the 6 position connector between pins 2 and 3. On the 12 position connector between pins 1&2 and also pins 10&11. Viewed from the solder eyelet side of the connectors, the pins are numbered and wired as shown below:



Procedure

1. Unpack and check all parts against the Parts List. Sort into piles: ICs, resistors, capacitors, 8 pin IC sockets, 14 pin IC sockets, LED & diodes, connectors, wire & solder. Set the ICs aside until assembly is complete.

2. Mount all 8 pin IC sockets. Solder all pins.

3. Mount all 14 pin IC sockets. Solder all pins.

4. Mount all resistors. R1,2,3,4,6,7,11,12, and 13 mount vertically. R8,9,10,16, and 17 mount horizontally. Solder, then clip excess leads. Retain lead clippings for later use.

5. Mount all capacitors. Note carefully the difference between the 1.0 and the 0.1 mfd capacitors. Solder, then clip the excess leads.

6. Cut a piece of hook-up wire 2" and strip 1/8" insulation off each end. Insert and solder to the holes adjacent to OI1 and U2. Refer to the Component Layout Diagram.

7. Cut a piece of hook-up wire 3" and strip 1/8" insulation off each end. Insert and solder to the holes adjacent to the LED jack and directly above J2. Refer to the Component Layout Diagram.

8. Mount and solder the two trim pots. R14 is 10K and R15 is 50K.

9. Mount all phono jacks. Using the excess leads cut from the resistors, connect the center pins of the jacks as indicated on the Component Layout Diagram to the corresponding holes on the foil side of the board. Solder all connections.

10. Use a 2" length of two conductor cable to connect GND to pin A and V_{cc} to pin B of the 6 position edge card connector. Note that the cable is color coded to help make proper connections.
WARNING An improper connection to this connector could seriously damage every component!

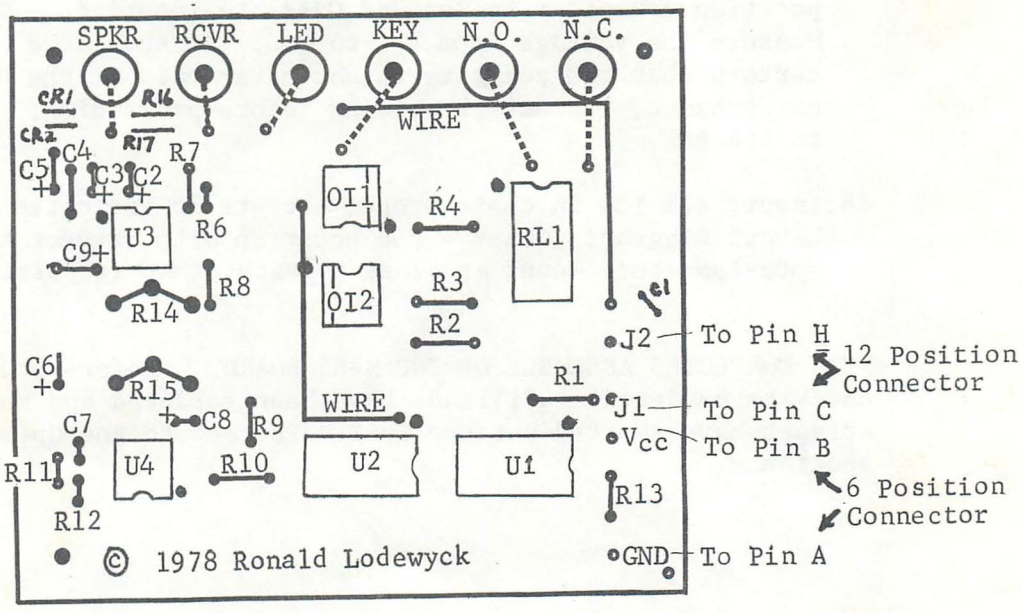
11. Use a 5 1/2" length of the two conductor cable to connect J1 to pin C and J2 to pin H of the 12 position edge card connector.

12. Make up the LED cable assembly using the remainder of the two conductor cable cut to a convenient length.

13. Make certain that the power is off to the PET computer. Plug in the 6 position connector to the 2nd Cassette Interface. Turn on the PET. Measure the voltage from V_{cc} to GND. It should be +5.0 volts. Be certain that the polarity is not reversed. If the correct voltage is not present, correct the wiring before proceeding. Turn off the power to the PET.

14. Insert all ICs in their proper sockets as indicated on the Component Layout Diagram. Observe the position with respect to pin 1. The two opto-isolators mount as close to each other as possible.

THIS COMPLETES ASSEMBLY OF THE M-65 BOARD. Before proceeding, carefully check to be certain all leads have been soldered and that no solder bridges have shorted out the foil. Proceed to the Operating Instructions section.



OI1, 2	Optical isolators	C5	1.0 mfd tamtalum		R8	3.3K	O/O/R
RL1	Reed Relay	C6	22 mfd electro.		R9	2.2K	R/R/R
U1	7404	C7	.022 mfd mylar		R10	5.6K	G/BLU/R
U2	7486	C8	0.1 mfd tantalum		R11	68K	BLU/GRY/O
U3	567	C9	0.1 mfd tantalum		R12	2.2K	R/R/R
U4	555	R1	1 K	BR/BL/R	R13	10 K	BR/BL/O
CR1, 2	Diodes (1N914)	R2	270	R/V/BR	R14	10K Trim pot-Red or WHT	
C1	.01 mfd disc	R3	330	O/O/BR	R15	50K Trim pot-BLU or BLK	
C2	0.1 mfd tantalum	R4	330	O/O/BR	R16	4.7K	Y/V/R
C3	1.0 mfd tantalum	R6	330	O/O/BR	R17	4.7K	Y/V/R
C4	.047 mfd mylar	R7	10K	BR/BL/O			

COMPONENT LAYOUT DIAGRAM for the M-65

OPERATING INSTRUCTIONS

Setting Up

The M-65 is attached to your radio equipment and to your PET microcomputer by means of several connectors on the PC board as shown in Figure 1. Given below is an explanation of each connector and two adjustments which should be made:

Phono Jacks

SPKR Connect to a pair of low impedance HI-FI type headphones or to a small speaker. This is the output of the side tone oscillator which may be used to copy Morse code generated: i) using the Morse trainer feature, ii) via the manual key input, iii) from the keyboard, or iv) by "processing" the receiver audio tuned to a CW station. This jack may also be used to create Morse code practice tapes by connecting to the AUX jack of a tape recorder.

RCVR Connect to your receiver audio - i.e. to the headphone jack or directly to the speaker terminals. Since you will probably want to hear the audio as well as feed it to the M-65, you should leave the plug only partially plugged into the headphone jack. Some rigs have jacks with an intermediate position allowing simultaneous listening on the speaker and headphones. If you do not have such a jack, you may prefer to connect direct to the speaker terminals (in parallel with the speaker).
This jack may also be connected to a tape recorder earphone output allowing prerecorded messages (such as Morse code practice tapes or RTTY pictures) to be replayed at any time.

LED Connect to the light emitting diode (LED) via the cable provided to give a visual indication of proper tuning. Place the LED in any location easily seen while tuning the receiver. It is best to view the LED straight forward rather than from the side. When a signal - either CW or RTTY - is properly tuned in, the LED will light brightly in synchronization with the sending station. It will also light in conjunction with input from the KEY jack.

KEY This jack serves two functions: manual key or external terminal unit input. If it is desired to display hand sent Morse code, attach directly to a straight key, "bug", or electronic keyer. For RTTY reception, it is possible to use a more sophisticated TU than the built-in PLL demodulator. See the appendix for connections.

NO Normally Open relay contacts. Connect to CW key jack - or - on RTTY connect to FSK jack or AFSK input terminals to give Open-on-MARK, Close-on-SPACE. See the appendix for more information.

NC Normally Closed relay contacts. Connect to FSK jack or AFSK input terminals to give Close-on-MARK, Open-on-SPACE. See the appendix for more information.

Edge Card Connectors

**** W A R N I N G **** Turn the PET power off before connecting or disconnecting these two connectors. Failure to do so could short out various pins resulting in serious damage to the PET and/or the M-65. Do not force either plug. They should slide on easily. Be certain that the polarizing keys are lined up with the slots in the PET PC board. You can damage the entire PET main logic PC board if you do not handle these connectors with care!

6 Position - Connect to the 2nd Cassette Interface contacts on the rear panel of the PET. This is the connector closest to the left edge of the cabinet

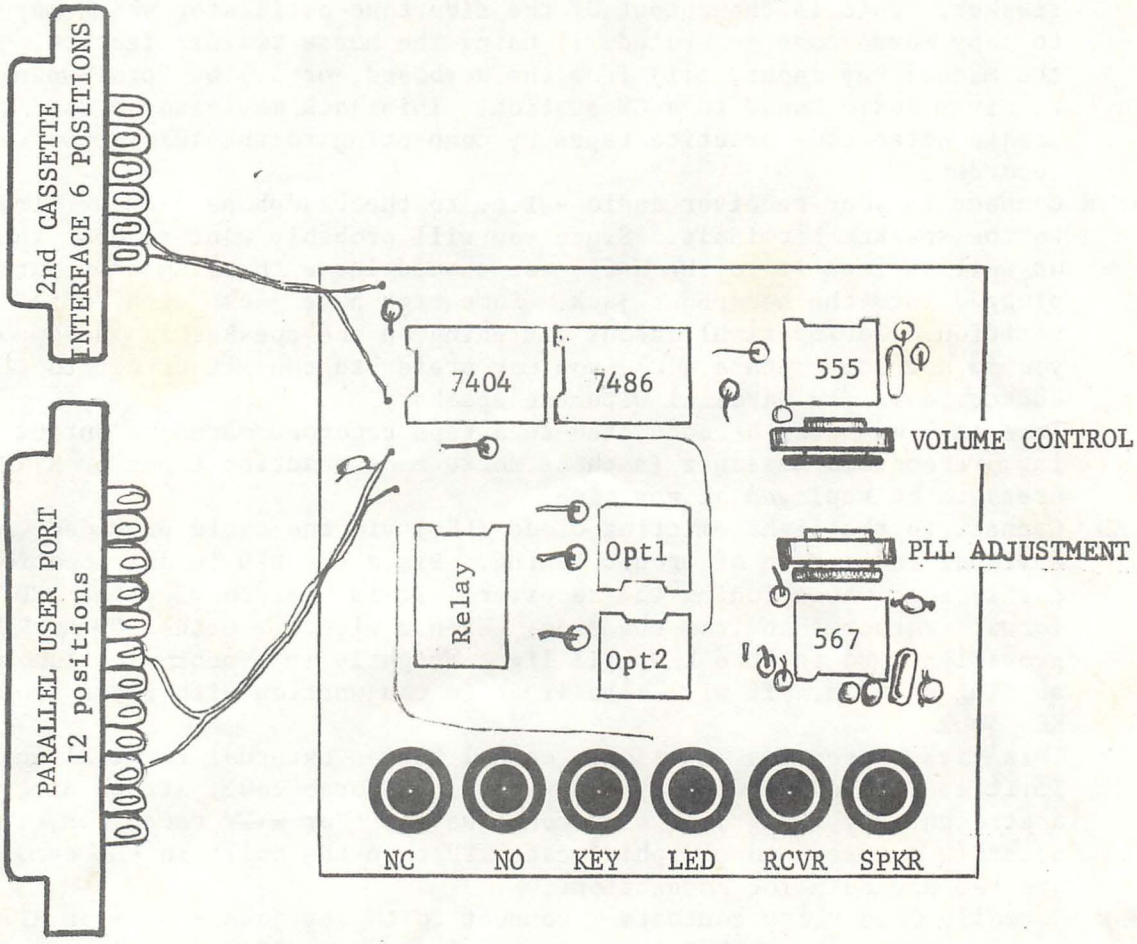


Figure 1. Connectors and Adjustments

when viewed from the rear of the PET. Note that this connector has a slot between positions 2 and 3, preventing the connector from being inserted upside down. As a further check, the wires from the M-65 should be on the bottom edge of the connector.

12 Position - Connect to the Parallel User Port. This connector is second from the left when viewed from the rear of the PET. Note that this connector has two slots: between positions 1&2 and also between positions 10&11. As a further check, the wires from the M-65 should be on the bottom edge of the connector.

Adjustments

Two PC Trim Pots allow adjustment of the PLL frequency and the side tone volume.

PLL Adjustment - It will be necessary to adjust this control to correspond to the desired frequency of the audio signal coming into the RCVR jack. For best results, this would correspond to the center of the receiver passband. The range of adjustment is approximately 800 to 2200 Hertz.

After making all the above connections, turn on the PET and your receiver. For HF reception: turn on the receiver calibrator. Select the desired filter selectivity (USB, LSB, CW, RTTY, etc.) on your receiver. Tune in the calibrator for maximum signal strength on the S-meter. Now turn the PLL adjustment until the LED lights brightly. Continue turning the adjustment until the light goes out. Back up the control to the middle of range for the LED on. Turn the calibrator off. Tune in a CW signal so that it indicates maximum S-meter reading. Now slowly rock the dial back and forth until the LED flickers in synchronization with the sending station. On some receivers, tuning may be quite critical depending on the dial tuning ratio. You might prefer doing the fine tuning using an RIT control if your rig has one. To tune an RTTY station, set the receiver to the SPACE frequency. If the LED lights when the station is pausing, you are tuned to the MARK, not the SPACE - move the dial slightly so the LED is off when the station is not sending a character, but fickers brightly when a character is sent.

For VHF-FM reception: On RTTY, have a friend send RY's on the channel. Turn the PLL adjustment until the LED flickers brightly. Now have your friend send : T then wait a second, T, then wait a second, T, then wait a second, etc. for about a minute. Slowly tune the PLL adjustment so that the LED is on when he sends T, but off when he is waiting. The LED should now be set to light on SPACE, but go off on MARK. On CW, have a friend send a continuous tone on the channel. Turn the PLL adjustment until the LED lights brightly. Note that the LED is now set for this specific tone so that the sending station must send the same tone all the time.

Volume - Controls audio level output from the side tone oscillator. Adjust for comfortable listening level on either headphones or a speaker.

Operating

After all the connections and adjustments indicated in the previous section have been made, you are ready to load the software. You will notice that the cassette contains a different program on each side : MORSE and RTTY. Program MORSE allows sending and receiving Morse code as well as generating random words for training. Program RTTY allows sending and receiving radioteletype. Select the desired mode, insert the tape cartridge in the cassette deck, rewind it, then press SHIFT-RUN. It should take approximately 4 minutes to load the program. It will take another minute or two for the program to initialize all variables and load the machine language subprograms. When the program is ready, a question will appear on the screen.

Program MORSE

The first question to appear will be:
MODE(S=SEND&RECEIVE, C=CODE PRACTICE)?

Enter S if you wish to send send from the keyboard and/or receive via the RCVR or KEY inputs. Enter C if you wish to generate random code for training.

The next question to appear will be:
ENTER SPEED IN WPM?

The speed entered will determine the keyboard sending speed, the speed of the random code, and also initialize the receiving speed. For receiving, however, the speed will be automatically adjusted to compensate for changes in the incoming signal speed. The range of allowable speed is 1 to 100 words per minute[1]. The number of words per minute is defined here as the number of 50 bauds per minute - i.e. the number of times the word PARIS will be sent in one minute[2]. Spacing is fixed at the ratio of:

1 for Dit
3 for Dah
1 for interelement space
3 for character space
7 for word space

SEND&RECEIVE

The system will now be in the Send mode. Typing on the keyboard will key the relay and the side tone oscillator. In addition to the standard letters of the alphabet (A-Z) and punctuation (? - . , /) there are also five special characters:

$\overline{AR}$	.-.-.	press @
$\overline{AS}$	.-...	press ⌐
Error.....		press ¬
$\overline{KN}$	-.--.	press <
$\overline{SK}$	...-.-	press >

[1]The program and M-65 board are capable of considerably greater speeds. The practical limit of most radio equipment, however, is around 60 WPM.
[2]See Lizee,"Speed Standards for the International Morse Code" Ham Radio, April 1973, page 68.

The keyboard is buffered (10 characters maximum) which allows typing ahead. Note: if you exceed 10 characters ahead, the buffer overflows and deletes the first 10 characters - so do not type so fast that this is likely to happen.

Special Functions

Several special functions are available from the keyboard. These are obtained by depressing the HOME key and then one of several keys as shown below:

HOME % Change speed. Returns the question

ENTER SPEED IN WPM?

After the speed has been entered, the program returns to the Send mode.

HOME & Create a canned message. Returns the request:

ENTER MESSAGE # (Ø THRU 9)?

Up to 10 different messages of 255 characters maximum each may be stored and sent later. Each time a particular message number is selected, the previous contents will be deleted and characters entered from the keyboard will be stored for later recall. To terminate a message, press the reverse (RVS) key (do not press the HOME key first). The program returns to the Send mode. If a mistake is made while typing the message, you have two options:

1. Enter RVS and redo the entire message.
2. Press the delete (DEL) key to insert an error character. Retype from the mistake on.

HOME n Where n is one of : Ø, 1, 2, 3, 4, 5, 6, 7, 8, 9.

Send canned message number n. The entire contents of the message previously stored in message number n is sent. If no message was previously created, nothing is sent. Note: if a mistake is made by pressing the wrong message number, you can only terminate the message by pressing the STOP key. This, however, terminates execution of the program. To restart, simply type:

GOTO 1ØØØ

The program will immediately return to the Send mode.

An example will illustrate the process of creating and sending canned messages:

```
HOME &
ENTER MESSAGE #(Ø THRU 9)? Ø
ENTER MESSAGE #Ø
USE RVS TO TERMINATE MESSAGE
THE QUICK BROWN FOX JUMPED OVER THE LAZY
DOGS BACK 123456789Ø RVS
ENTERED - RETURN TO SEND
HOME &
ENTER MESSAGE #(Ø THRU 9)? 1
ENTER MESSAGE #Ø
USE RVS TO TERMINATE
TIMES. RVS
ENTERED - RETURN TO SEND
HOME Ø HOME 1
THE QUICK BROWN FOX JUMPED OVER THE LAZY
DOGS BACK 123456789Ø TIMES.
```

HOME RVS Jumps to the Receive mode. Terminates Send mode.
In the Receive mode, the system will decode well-sent Morse code and display it on the video monitor. Due to noise (QRN), interference (QRM), fading (QSB), and non-uniformity of hand sent Morse code, 100% perfect copy is not usually attainable. If a station is tuned in which is sending at a significantly different speed (more than ± 10 WPM) from the last speed setting, it is better to return to the Send mode (press the RVS key) and reinitialize the speed. Minor speed differences are easily corrected for by the program and no action is required. Of course, computer generated Morse will be easier to copy, even at high speeds, but is still subject to QRN, QRM, and QSB.

Morse Code Trainer

If a C is entered in response to the initial question:

MODE(S=SEND&RECEIVE, C=CODE PRACTICE)?

the program will generate random Morse code for training purposes. Following the request to input the speed:

ENTER SPEED IN WPM?

the program will ask:

RANDOM CHARACTERS OR WORDS(C OR W)?

If a C is entered, the computer will generate random characters, including numbers and punctuation, in 5 character groupings. For example:

XJ6/A VCE4. -UIOP 2ØZ/S DSEET 8L2C,

etc.

If a W is entered in response to the question, the computer will generate 5 letter words. For example:

RADIO CHINA LIGHT FIXED PLATE FINAL

etc.

To terminate sending the random Morse code, simply depress the space bar. At the completion of the current 5 characters, the program will return with the request ENTER SPEED IN WPM?

This feature allows changing the speed of the trainer at any time. It also allows switching back and forth from word to character groupings.

If it is desired to switch from one mode (Send&Receive or Code Practice) to the other, it is necessary to stop execution with the STOP key and then enter the RUN command.

Program RTTY

When the program is loaded and ready, the word READY will appear in reverse video on the screen. The system is now in the Send mode. Typing on the keyboard will key the relay. In addition to the standard letters of the alphabet (A - Z) and numbers (Ø - 9), the Baudot (Murray) code used on RTTY also uses the special characters:

-	dash
?	question mark
$	dollar sign
!	exclamation point
& or +	ampersand or plus
#	pound sign
,	comma
Bell	(not available on the PET)

;	semicolon
/	slash
"	quotation marks
<	LTRS - shift to lower case
>	FIGS - shift to upper case
	space
CR	carriage return
LF	line feed

one key - RETURN - on the PET

Depressing any other key on the PET keyboard will result in the character being printed locally, but not sent. While the PET has all but the Bell characters, you will find many RTTYers using teletypewriters or other equipment which does not. Check with the other station before sending any punctuation. The Baudot code requires a FIGS character before shifting to upper case characters (numbers and punctuation) and a LTRS character before returning to lower case (letters). It is not necessary to type these on the PET since program RTTY will send them automatically. If however, you should ever wish to send these characters manually, they are available on the keyboard as shown above. Note that a LF and a CR character will be sent when the RETURN key is typed.
The keyboard is buffered (10 characters maximum) which allows typing ahead. Note: if you exceed 10 characters ahead, the buffer overflows and deletes the first 10 characters.

Special functions

Several special functions are available directly from the keyboard. These are obtained by depressing the HOME key and then one of several keys as shown below:

HOME & Create a canned message. Works same as program MORSE.

HOME n Send canned message number n. Works same as program MORSE.

HOME T Send the time as follows:

THE TIME IS HH : MM UTC

where HH is the present hour (ØØ to 23) in Coordinated Universal time,
and MM is the present minute (ØØ to 59) in UTC.
It is necessary to initialize the PET clock to UTC before sending the time with this feature. To do so, press STOP. Then enter:

TI$ = "HHMMSS"

where HH is UTC in hours,
MM " " " minutes, and
SS " " " seconds.
To return to the Send mode, now enter:

GOTO 1ØØØ

HOME RVS Jumps to Receive mode. Terminates the Send mode.

In the Receive mode, the system will decode a properly tuned RTTY signal and display it on the screen. Tuning is critical - garble will result from a poorly tuned signal. You have your receiver VFO tuned properly if:

1. the LED is off on MARK (sending station idle)
2. the LED is on on SPACE (the LED flickers brightly as RTTY characters are received).
3. good copy is being displayed on the sceen.

It will take some practice to quickly adjust the receiver VFO to obtain

good copy. Under good signal conditions, 100% copy is certainly attainable using the M-65. However, as with program MORSE, QRN, QRM, and QSB may cause some loss of copy. A better terminal unit (TU) might be used to improve copy under marginal signal conditions. See the appendix.
Most RTTY stations use a 72 character line of text. The PET has only 40 characters available on each line. Therefore, most text will require two lines on the PET video display for each line at the other station.
Note that this means while sending from the keyboard, you should press the RETURN key at least once every 72 characters. Even though the cursor moves on the screen to the next line automatically when 40 characters are exceeded, the LF and CR characters are sent over the radio only when the RETURN key is dpressed.
To return to the Send mode, press the RVS key. Note: depressing the RVS key will not return you to the Send mode unless the LED is lit. Therefore you must either:

1. press RVS just before the sending station sends the last character of his transmission (usually a K or SK), or
2. attach a straight key or switch to the KEY jack. Press the key at the same time the RVS key is depressed.

The key jack is not connected to the relay, so it is necessary to key your transmitter directly for CW identification. If you are new to RTTY, you would do well to read an introduction[3,4,5] before sending on the air.

HINTS AND KINKS

1. Generally it will require a signal strength of at least S3 or S4 for good CW copy and at least S6 or S7 for good copy using the builtin PLL demodulator.
2. High background noise results in poor copy. Some QRN is caused by the PET. (virtually all microcomputers create RF noise interference). If you encounter a severe problem, you might consider:
   i) Make sure the rig is connected to a good earth ground.
   ii) Connect your antenna with coaxial feedline. Open line feeders will frequently pick up RFI from the microcomputer and feed it directly to the receiver.
   iii) Enclose the PC board in a metal cabinet and ground it to your rig. In severe cases, bypass all leads including those to the PET with .01 mfd disc capacitors to ground and replace the connecting wires with shielded cable.
3. If the program should hang up at any time or abnormally terminate execution, it is possible to return quickly to the Send mode on both MORSE and RTTY by pressing the STOP key and the entering the command:
   GO TO 1ØØØ
4. The PC board may be used for many other purposes besides a Ham Interface. The side tone oscillator may be used whenever an audio tone is desired. For example,as a replacement for a bell or as an alarm. With a speaker

[3] Radio Amateurs Handbook, ARRL, Newington, CT.
[4] RTTY Handbook, 73 Magazine, Peterborough, NH 03458
[5] RTTY Beginners Handbook, RTTY Journal, PO Box RY, Cardiff by the Sea,CA 92007

attached to SPKR, the following program is actually a very distinctive ALARM CLOCK!

```
1Ø POKE59459,1 : POKE59471,1
2Ø  ?"ENTER THE PRESENT TIME(HHMMSS)";T$
3Ø TI$=T$
4Ø ?"ENTER WAKEUP TIME(HHMMSS)";T$
45 ?"■" : REM PRINT THE CLEAR SCREEN CHARACTER TO PREVENT
                BURNING IN AN IMAGE ON CRT.
5Ø IF TI$>T$ THEN 1ØØ
6Ø REM CURRENT TIME IS LESS THAN ALARM TIME
7Ø IF TI$<T$ THEN 7Ø
8Ø FOR I=1 TO 1ØØØ : POKE59471,Ø : FOR J=1 TO 3Ø : NEXT
9Ø POKE59471,1 : FOR J=1 TO 5Ø : NEXT : NEXT : STOP
95 REM WAIT TIL AFTER MIDNITE
1ØØ IF TI$>"ØØØØØØ"  THEN 1ØØ
11Ø GO TO 7Ø
```

The board may also be used as a one bit Input Port. Whenever the KEY jack is grounded, location 59471 will equal 255. When the KEY jack is ungrounded, location 59471 will equal 239. Thus an input to the KEY jack can be used to trigger a program using the following statement:

```
1Ø IF PEEK(59471) = 239 THEN 1Ø
2Ø whatever on key down....
```

5. Side tone oscillator. The frequency of the side tone may be changed by replacing resistor R11. Reducing the resistance increases the frequency. A 100K pot could be inserted in place of R11 to give an adjustable side tone frequency.
6. PLL frequency. If an audio frequency is desired which falls out of the range of adjustment of R14, the range may be altered by changing R8. Increasing R8 decreases the PLL frequency and vice versa.

TROUBLE - SHOOTING

Symptom	Possible problem	Check out procedure
LED won't light	1.LED bad or polarity reversed	a.Measure voltage across LED jack. Should be +2.0 v with signal tuned in, +1.0 v no signal. b.Reverse leads if correct voltage present.
	2.Bad 567 or PLL circuit	c.As above a. If voltage does not vary with presence of signal, check all wiring to 567 Check wiring at RCVR jack.
	3.V_{cc} polarity reversed or absent	d.Voltage at pin 4 of 567 should be +5.0 v to GND. Check wiring of 6 pin edge conn.
LED ok - receiving program not working	1.7404 bad	a.Listen to side tone - should go on & off in synch with incoming signal.
	2.Optical isolator bad	b.If a. checks ok, pin 5 of OI2 should go from +0.2 to +5.0 v in synch with signal.
	3.Wrong pins on 12 position connector	c.If a. & b. ok, enter the following: FORI=1TO1ØØØØ:?PEEK(59471):NEXT in the immediate mode. Should get 239 with no signal and 255 with signal present. Other- implies wrong pin connections.

Symptom	Possible problem	Check out procedure
CW signal inverted	CW jack connected to NC contacts of relay	Connect CW jack to NO contacts of relay.
RTTY signal inverted	FSK or AFSK jack connected to wrong relay contacts	Connect jack to opposite relay contacts.
LED flickers ok but copy garbled on RTTY	Tuning to MARK	Review RTTY tuning procedure - tune to SPACE.
Relay not being keyed	1.Optical isolator 1 bad or 7404 bad	a.Voltage at pin 4 of 7404 should be +0.2v when not sending and +4.5v key down (send a Ø at 1 WPM). b.Voltage at pin 5 of OI1 should be same as pin 4 of 7404.
	2.Wrong pins on 12 position connector	c.If a. ok, check pin 3 of 7404. Should be reverse of pin 4 (inverted). If not, check connection to pin C of User Port.

Appendix - RTTY

Keying

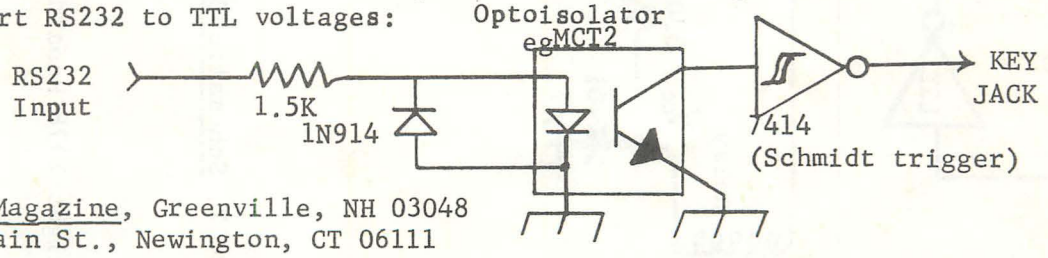
To send RTTY on the amateur HF frequencies, you will require a means of frequency modulating your signal. Two methods are in common use today:

1. Frequency shift key (FSK) the transmitter VFO. Some transmitters and transceivers (such as the Kenwood TS820, Yaesu FT901, Drake TR7, etc.) have this capability builtin. In this case, simply connect the FSK jack to the relay contacts on the M-65. You will need to determine if your FSK circuitry requires make-on-SPACE or make-on-MARK. Both are provided for on the M-65 board. If your transmitter does not have this feature, refer to Chapter V of the RTTY Handbook[4] or the RTTY section of the Radio Amateur's Handbook[3].
2. Audio Frequency shift key (AFSK) through the microphone input. This is the easiest and probably most common method in use on the Ham bands today. Several commercial AFSK units are available - look through any issue of The RTTY Journal[5], Ham Radio Magazine[6], QST[7], 73 Magazine[8], or World Radio News[9]. Loughmiller[10] described a simple but very stable AFSK unit. A very simple circuit was designed by WB2RHM and described in Sept.69 QST[11]. It should cost less than $10, and has provisions for wide or narrow shift, and also has a CW ID jack which makes it ideal for use with the M-65.

Terminal Unit

The builtin terminal unit (TU) of the M-65 consists of a single IC - the 567 - phase locked loop. This circuit is adequate to demodulate an FSK signal or CW signal under good signal conditions. In the presence of heavy QRN, QRM, or QSB, however, performance will be marginal. Several advanced design TU's are available commercially, including units made by HAL Communications, FLESHER, DOVETRON, INFOTECH, and ELECTROCOM. Several excellent TU's have been described in the literature, and many of the circuits are now available in kit form. Look through recent issues of the magazines mentioned above. To connect an external TU to the KEY jack of the M-65, you must have the output of your TU be in the form of: ground on SPACE, open on MARK. This may be accomplished several ways:

1. If your TU keys its own relay, just connect the relay contacts to the KEY jack.
2. If your TU has TTL compatible (0. to +5.0 volts) output, connect directly to the KEY jack.
3. If your TU has RS232 (-12 to +12 volts) output, conververt to TTL or key a relay. Then connect to the KEY jack. The following circuit shows how to convert RS232 to TTL voltages:



[6] Ham Radio Magazine, Greenville, NH 03048
[7] QST, 225 Main St., Newington, CT 06111
[8] 73 Magazine, Peterborough, NH 03458
[9] World Radio News, 2120 28th St., Sacramento, CA 95818
[10] Loughmiller, "Digiratt", Ham Radio Magazine, Sept. 1977
[11] WB2RHM, QST, September 1969

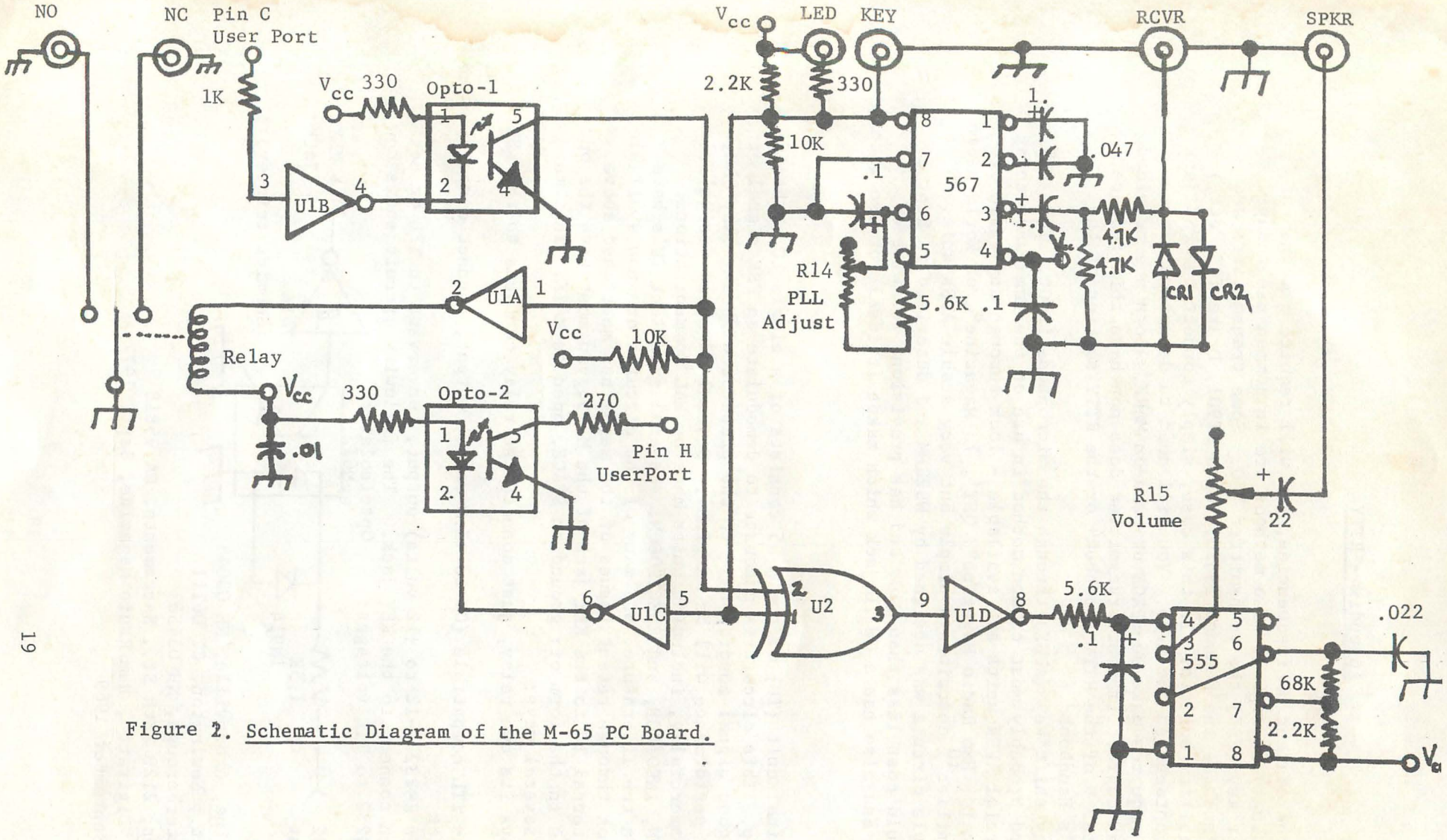


Figure 2. Schematic Diagram of the M-65 PC Board.

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